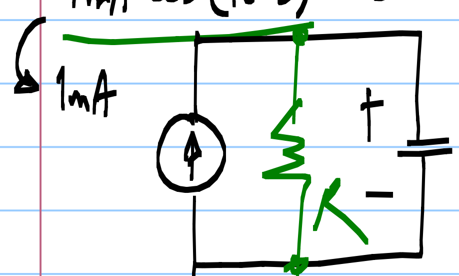
EC1010: Lecture 31

$\omega = 10^3$ $\quad 1\,mA \cos(10^3 t)$: $v_c = \sin(10^3 t)\,V$ $\quad i = C\frac{dv}{dt}$ $\qquad$ Solution for $t > 0$



$1\,\mu F$ $\quad v_c = 0$ @ $t = 0$ $\qquad \frac{1}{j\omega C} = -j\,10^3\,\Omega$

$1\,mA \sin(10^3 t)$: $\quad v_c = [1 - \cos(10^3 t)]\,V$

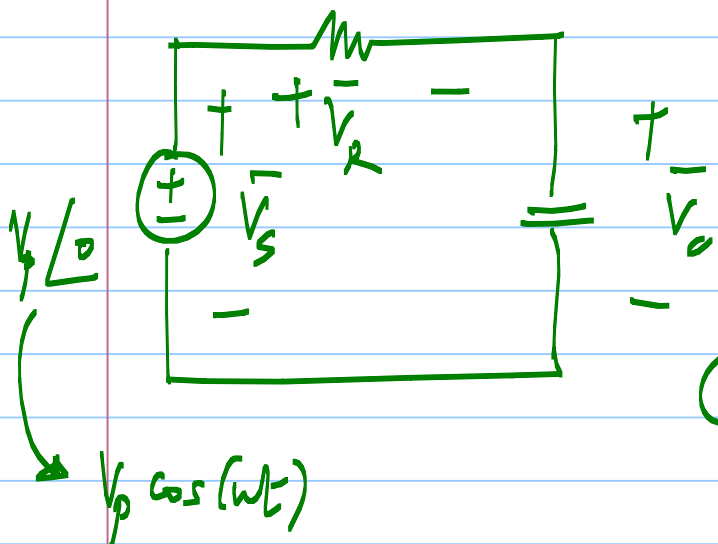
$1\,mA \quad \cos(10^3 t) \qquad \sin(10^3 t)$

$1\,mA \angle 0 \times (-j10^3\,\Omega) = -j\,V$

$1\,mA \sin(10^3 t) \quad [1 - \cos(10^3 t)]\,V$

$-j\,1\,mA \times (-j10^3\,\Omega) = -1\,V \rightarrow -\cos(10^3 t)\,V$

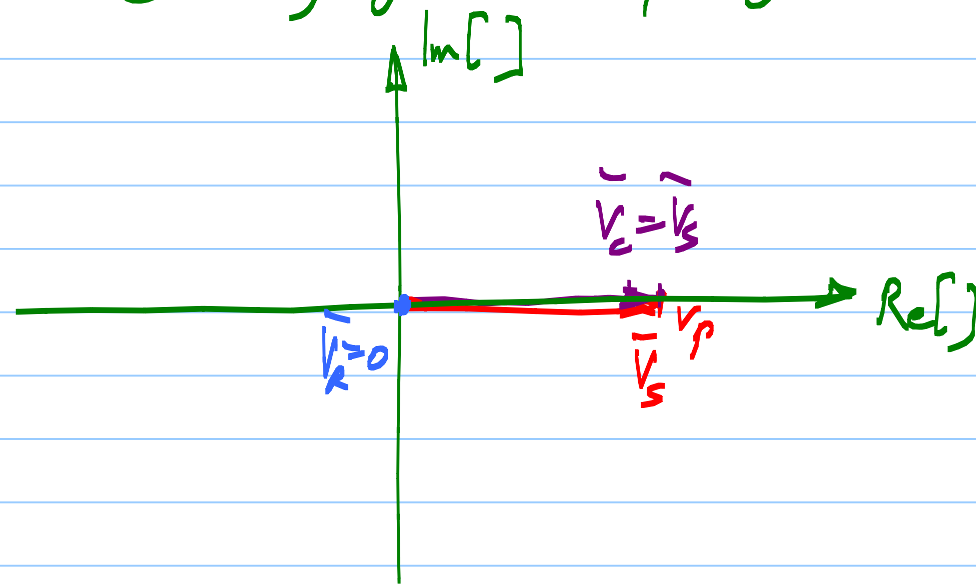
$\bar{V}_S = \bar{V}_R + \bar{V}_C$



$$\bar{V}_R = \frac{R}{R + 1/j\omega C} \cdot V_p = \frac{j\omega CR}{1 + j\omega CR} \cdot V_p$$

$$\bar{V}_C = \frac{1/j\omega C}{R + 1/j\omega C} \cdot V_p = \frac{1}{1 + j\omega CR} \cdot V_p$$

@ any given frequency: $\omega = 0$



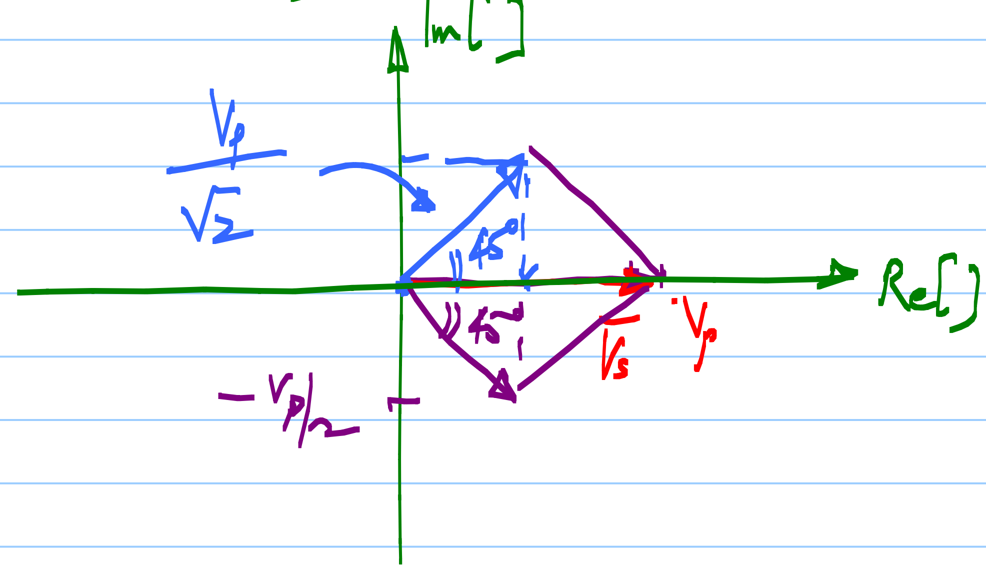
$$\frac{j}{1+j} \quad \pi/2 \quad \pi/4$$

$$\frac{1}{1+j} \quad 0 \quad \pi/4$$

$$\bar{V}_R = \frac{R}{R + 1/j\omega C} \cdot V_p = \frac{j\omega CR}{1 + j\omega CR} \cdot V_p$$

$$\bar{V}_C = \frac{1/j\omega C}{R + 1/j\omega C} \cdot V_p = \frac{1}{1 + j\omega CR} \cdot V_p$$

@ any given frequency: $\omega = 1/RC$



$$\frac{j(\ )}{1+j(\ )}$$

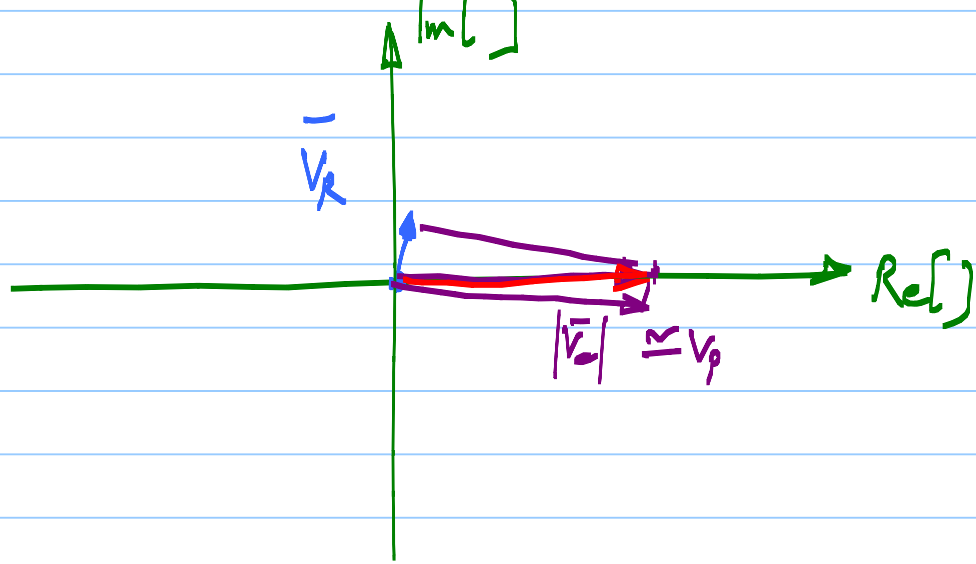
$$\bar{V}_R = \frac{R}{R + 1/j\omega C} \cdot V_p = \frac{j\omega CR}{1 + j\omega CR} \cdot V_p$$

$\omega \ll 1/RC$

$$\bar{V}_C = \frac{1/j\omega C}{R + 1/j\omega C} \cdot V_p = \frac{1}{1 + j\omega CR} \cdot V_p$$

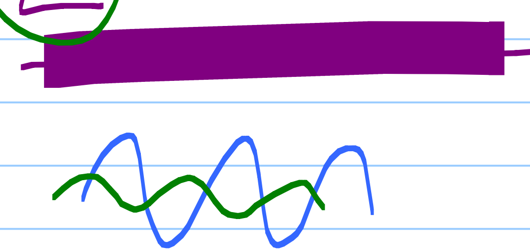
@ any given frequency:

$\omega = 0$



$$\bar{I}_C = j\omega C \cdot \bar{V}_C$$

$$\angle \bar{I}_C = \angle \bar{V}_C + 90°$$



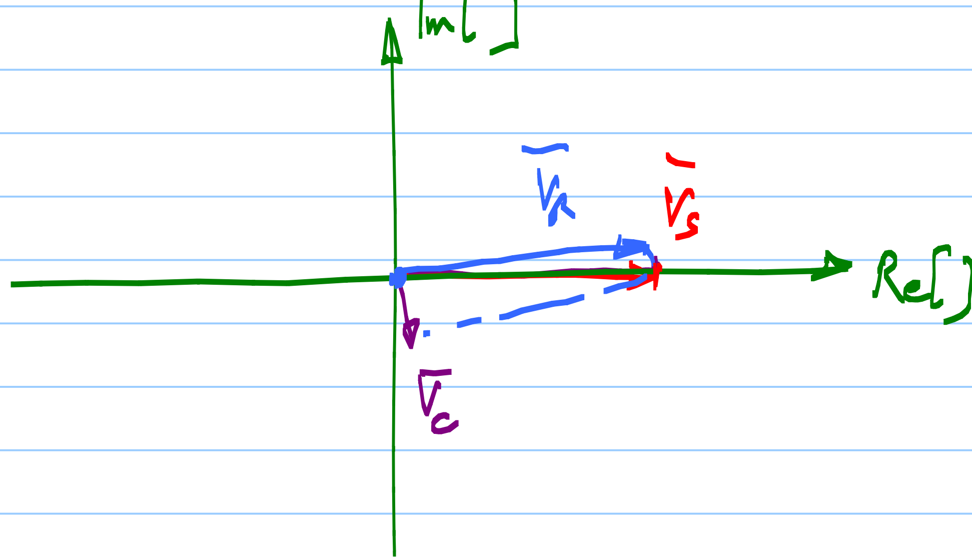
$$\bar{V}_R = \frac{R}{R + 1/j\omega C} \cdot V_p = \frac{j\omega CR}{1 + j\omega CR} \cdot V_p$$

$\omega \gg 1/RC$

$$\bar{V}_C = \frac{1/j\omega C}{R + 1/j\omega C} \cdot V_p = \frac{1}{1 + j\omega CR} \cdot V_p$$

@ any given frequency:

$\omega = 0$

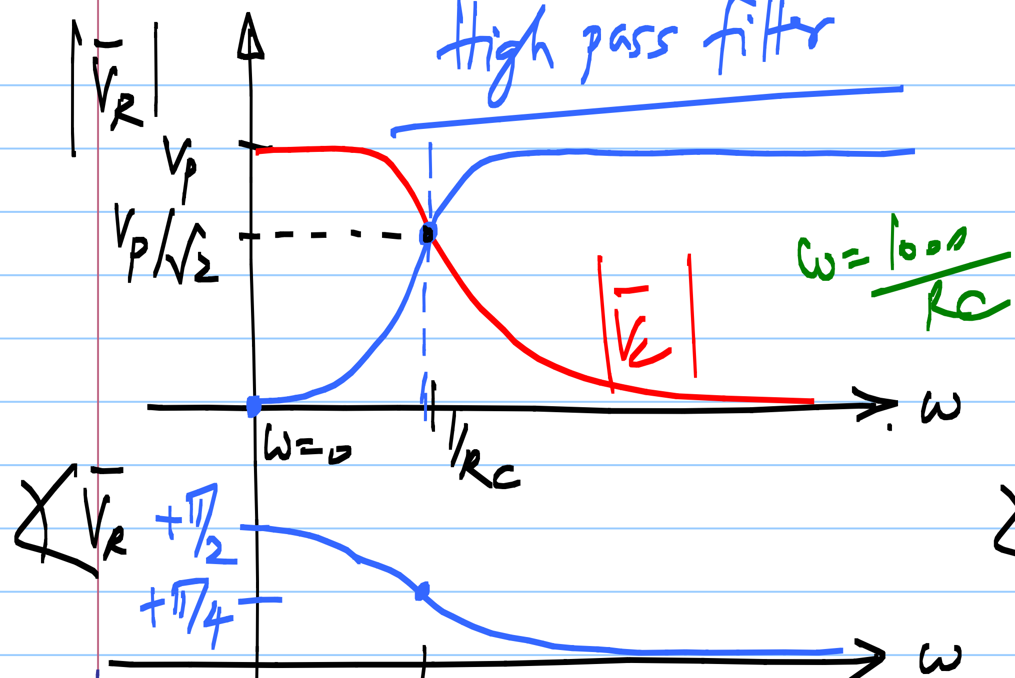


Magnitude & Phase versus frequency:

$\frac{|\bar{V}_R|}{|\bar{V}_s|}$, $\frac{|\bar{V}_c|}{|\bar{V}_s|}$ $\quad |\bar{V}_s|$

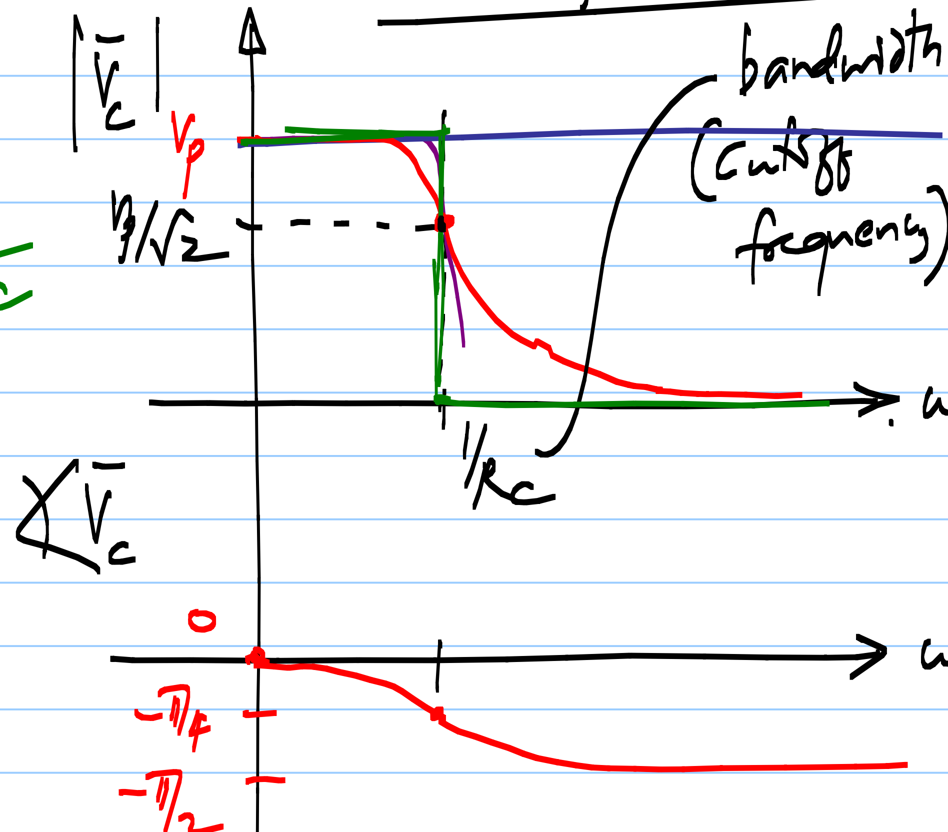
$V_p \cos \omega t$

ω ↑



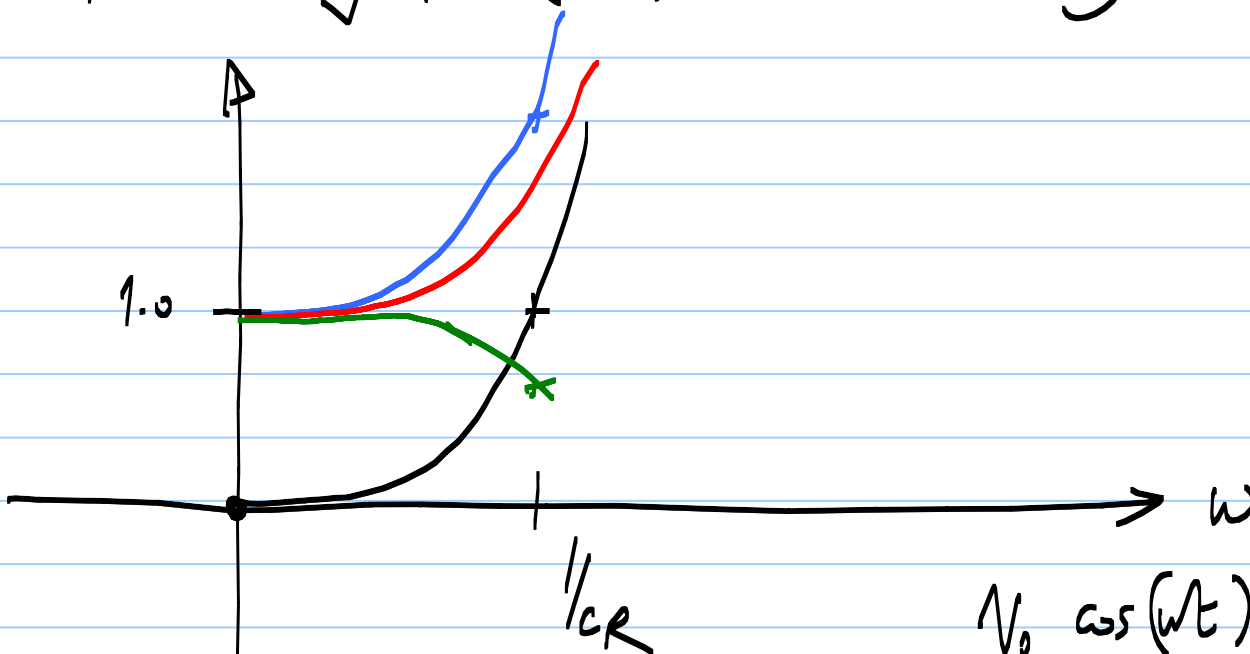
$$\bar{V}_R = V_p \cdot \frac{j\omega CR}{1 + j\omega CR}$$

V_c: low pass filter



$$\bar{V}_c = V_p \cdot \frac{1}{1 + j\omega CR}$$

$$\left|\bar{V}_c\right| = V_p \cdot \frac{1}{\sqrt{1+(\omega C R)^2}} \qquad \sqrt{1+(\omega C R)^2}$$



$$\frac{V_p}{\sqrt{2}} \cos(\omega t - \pi/4)$$

$$V_p \cos(\omega t)$$

$$\frac{\bar{V}_c}{\bar{V}_s} = H \qquad V_p |H| \cdot \cos(\omega t + \angle H)$$